

STUDIES ON MARINE BRYOZOA. IV. NOLELLA BLAKEI N. SP.

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INTRODUCTION

During the summer of 1946 while growing some *Perophora viridis*, a Protochordate, for use of students in the Marine Biological Laboratory (M. B. L.) invertebrate zoology course, the writer noted some small delicate *Nolella* colonies growing in the same culture dishes. Identification of the bryozoan species was difficult for two reasons: (1) because existing descriptions of various species of *Arachnidium*, *Arachnoidea*, and *Cylindroecium* or *Nolella* in all stages of their development are not as extensive as one might hope for and (2) the present specimens were studied in the living, growing state for only eight days, from August 25 to September 2, 1946; hence, only a few colonies could be observed and these mostly in the young, developing stage. Because of the desire to report the form so subsequent workers or collectors could watch for it and study it more fully it was deemed advisable to publish the following data on the species.

COLLECTION AND GROWTH DATA

On August 14, 1946, the Marine Biological Laboratory supply department collected a quantity of *Perophora viridis* from Lagoon Pond, Martha's Vineyard, Massachusetts. The *Perophora* was conspicuously overgrown with *Aeeverillia armata* and hydroids. On August 16, some *Aeeverillia* sprigs and the greenest *Perophora* stolons and buds were selected and cut into 10 to 15 mm. lengths for culturing (as in Figs. 1, 2). The watch glasses with their taped colony fragments were immersed upside down in racks (Fig. 2) in large laboratory aquaria into which natural sea water was piped from a near-by bay. In time the *Aeeverillia* and *Perophora* fragments developed colonies with stolons radiating in several directions over the bottom of the glass (Fig. 1). These watch glasses were studied daily under the microscope. On August 25 *Nolella* stolons and bases were discovered in ten watch glasses. These were watched daily till September 2, when observations had to terminate. The specimens were identified as one of the Ctenostomata, family Nolellidae, genus *Nolella*, new species. It was finally named *Nolella blakei* in honor of a most esteemed professor and kindly adviser, Dr. Irving Hill Blake of the University of Nebraska.

MORPHOLOGY OF NOLELLA BLAKEI N. SP.

The young zoarium is soft, transparent, and inconspicuous. It consists of thread-like "stolons" and basally adherent, upright columnar zoids whose tips are squared. Very young zoids arise as squared peristomes from flattened, enlarged bases which have temporarily serrated borders.

"Stolons"

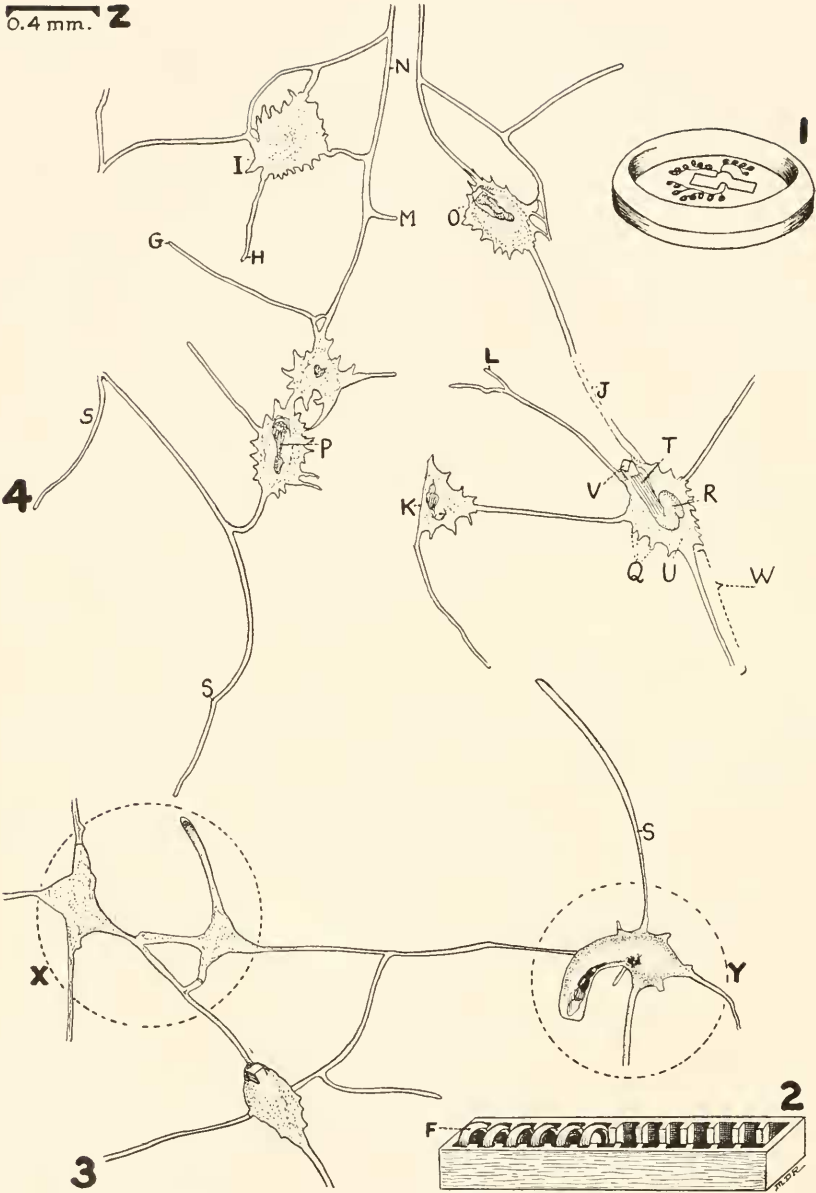
Annandale (1907, page 199), Harmer (1915, page 43), Silén (1942, page 6) and others questioned the suitability of the term "stolon" for the long creeping processes connecting the zooids of some Ctenostomes because these processes are really extensions of the zooid bases and are sometimes not closed off by a septum from the main body cavity of the zooid. See Figures 7, 12, 13, and 19 (W) for such stolons in young *Nolella blakei*. Some of the young *Nolella blakei* stolons have septa at their origin, others do not. The younger the colonies the more apt are they not to have yet formed septa. Whether there are some non-septate "stolons" in old *Nolella blakei* individuals is not known because the older zooids (Figs. 15, 17, 18) were torn from the taped *Perophora* so complete stolons were not generally obtained. The following description of *Nolella blakei* "stolons" is therefore based

TABLE I
Measurements of Nolella blakei n. sp.

	Maximum	Minimum	Average	No. of readings
Tentacle number	12	8	10	13
"Stolons"				
Length	2.296 mm.	0.155 mm.	0.767 mm.	35
Width	.046 mm.	.015 mm.	.029 mm.	33
Upright, retracted zooid:				
Length of vertical part, exclusive of proximal "stolon"	.899 mm.	.697 mm.	.775 mm.	3
Width	.093 mm.	.076 mm.	.049 mm.	3
Basal enlargement (exclusive of stolons):				
Length	.472 mm.	.328 mm.	.397 mm.	20
Width	.341 mm.	.205 mm.	.268 mm.	20
Number of small pointed extensions, exclusive of stolons, from the basal enlargement border, in young colonies	17	4	10	19

largely on conditions in young colonies. The "stolons" are thin-walled, slender (0.015 to 0.046 mm. in diameter), anastomosing, short or long (0.155 to 2.296 mm.) and adherent along their entire length. Three to five "stolons" originate from the zooid base (Fig. 5). They are generally separated by a septum at their proximal end or point of origin from the distal end of the basal enlargement (Figs. 7, 13). "Stolons" may grow into each other and establish new connections with other zoecia (see the solid black lines in Fig. 5) in a relatively short time (two days). Zooids arise as buds from the "stolons" (Fig. 10, A). The basal enlargement itself appears to have been formed at the distal end of a "stolon" from which it was not separated, at least in young colonies. Additional data on "stolons" and other parts are given in Table I.

PLATE I



EXPLANATION OF PLATES

All figures except 1, 2, 6 and 13 were drawn with the camera lucida. All but Figures 1 and 2 are of the new species *Nolcella blakei*. Figures 3, 7, 10, 11, 12 and 14 were drawn from colonies growing in one watch glass; Figures 4, 5, 8, 9, 16 from another and Figures 15, 17, 18 from colonies in a third watch glass.

Basal enlargement

The flattened basal enlargement of *Nolella blakei* is delicate, soft, transparent, and irregular in outline. It sometimes tends toward a rough diamond shape (Figs. 7, 8, 19). It is conspicuous in young colonies having a crenulate or serrate border in young zooids but is not noticeable in the few available older zooids (Figs. 15, 17,

TABLE II
Comparison of tentacle numbers in related species

Tentacle number	Species	Primary or secondary reference sources
12-16	<i>Arachnidium fibrosum</i>	Marcus, 1938, p. 51; 1941, p. 27
26-30	<i>Arachnidium irregulare</i>	Harmer, 1915, p. 49
16	* <i>Arachnidium ray-lankesteri</i>	Rousselet, 1907, p. 255
18-20	<i>Arachnidium simplex</i>	Hincks, 1880b, p. 284
16	<i>Arachnoidea evelinae</i>	Marcus, 1937, pp. 130-131
16+	<i>Arachnoidea protecta</i>	Harmer, 1915, p. 50
about 18-20	** <i>Cylindroecium dilatatum</i>	Hincks, 1880a, p. 536
no data	<i>Cylindroecium horridum</i>	O'Donoghue, 1926, p. 61
about 10	<i>Cylindroecium pusillum</i>	Hincks, 1880a, p. 537
no data	<i>Cylindroecium repens</i>	O'Donoghue, 1923, p. 192
no data	<i>Cylindroecium spinifera</i>	O'Donoghue, 1924, p. 59
about 10	<i>Nolella alta</i>	Marcus, 1938, p. 55
16-20	<i>Nolella annectens</i>	Harmer, 1915, p. 59
8-12	<i>Nolella blakei</i>	present study
18-22	<i>Nolella gigantea</i>	Marcus, 1937, p. 132
about 18	<i>Nolella papuensis</i>	Harmer, 1915, p. 55

* Now *Arachnoidea* (Harmer, 1915, p. 51).

** Now *Nolella* (Marcus, 1938, pp. 53-55).

18) because the growing zoid cylinder gradually incorporates it. From its sides extend outward five to seventeen serrate processes (Figs. 8Q, 16) which adhere to the substratum and are apparently only of a temporary nature. In time they become obliterated by the enlarging zoid. In *Nolella blakei* these cuticular projections are

PLATE I

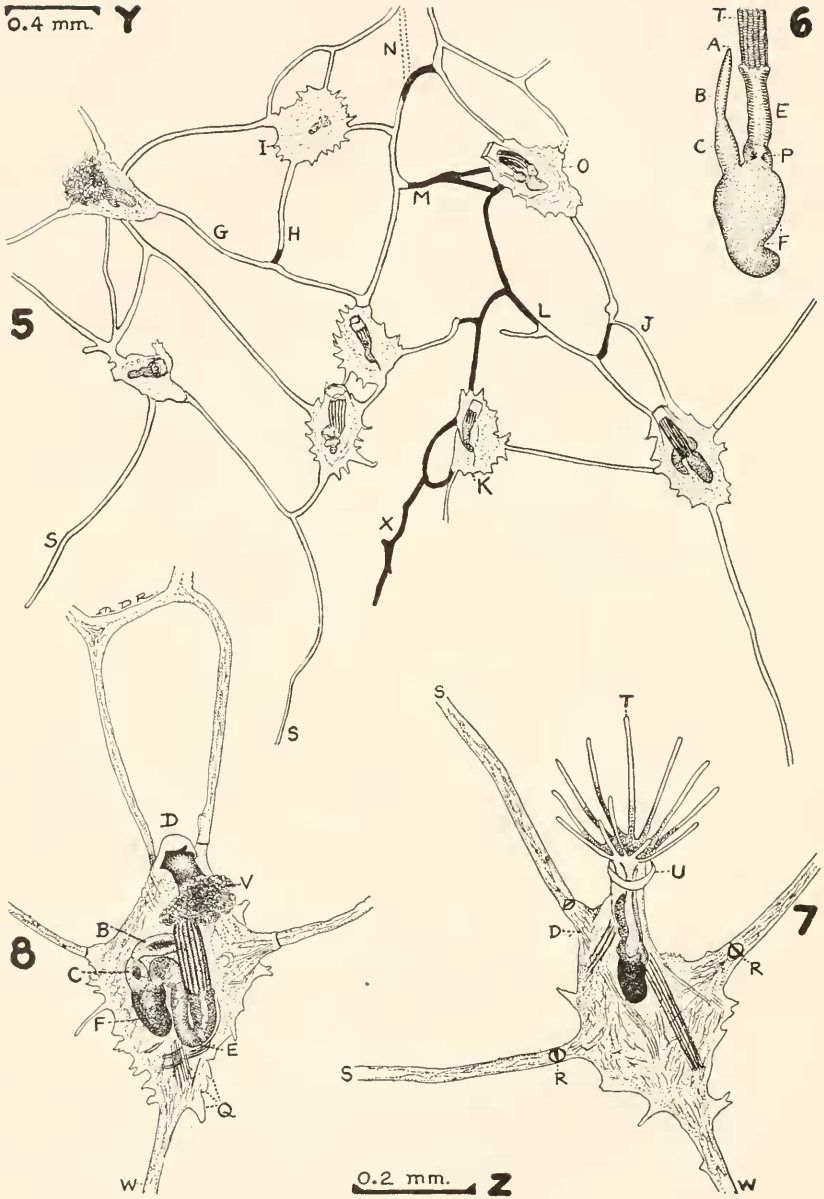
FIGURE 1. Diagram of a *Perophora* colony growing in a Syracuse watch glass from a fragment which had been fastened down with waterproof adhesive tape about one or two weeks before. *Aeверrillia* and *Nolella* grew under similar conditions along with the *Perophora*.

FIGURE 2. An open wooden rack containing several watch glasses (F) for culturing bryozoa and *Perophora*.

FIGURE 3. Part of very young *N. blakei* colony drawn on IX-1-1946. Circle X encloses two basal enlargements which as yet don't have a visible polypide and which are enlarged in Figure 10. Circle Y zoid is enlarged in Figure 14. Drawn to Scale Z. (S) Stolons.

FIGURE 4. Another young colony. The parts are labelled for comparison with Figure 5: (Q) basal serrations; (P) polypide; (R) gut; (T) tentacles; (V) squared peristome rim; (W) proximal extension of Zoid U and classed as one of its "stolons" (S). A transverse septum is absent from it for a considerable distance. Stolon J was damaged along the dotted area. Letters G, H, J, L, M, N all represent particular stolons in which changes occurred in the two days which elapsed between conditions depicted in Figures 4 and 5. Individuals I, K, O and U show a developmental sequence. The youngest (I) is a sac without a polypide (P). Drawn to Scale Z.

PLATE II



confined to the edge of the young basal enlargement and were not present over its upper surface nor along the upright cylinder, consequently differing in spination from *Arachnidium fibrosum*, *Cylindroecium* (*Nolella*) *spiuifera*, *C. horridum* (*N. horrida*) and *Nolella sawayai*.

Upright columnar zoid

The peristome rises upward from the basal enlargement, lengthening into a tall cylinder in time (Fig. 15). In retracted *Nolella blakei* zooids the peristomeal orifice is squared for a short distance (Figs. 12, 15, 16). In partly or fully extended zooids this character is not particularly noticeable (Figs. 7, 8, 11, 14, 18). This condition seems to obtain for *N. papuensis* also. In *N. annectens* the squaring appears to be of greater extent along the peristome than in *N. blakei*. The squared orifice distinguishes the genus *Arachnoidea* from *Arachnidium*. *Arachnoidea* has it while *Arachnidium* has a rounded peristomeal orifice. The main differences between *Nolella blakei* and the *Arachnoidea* species are in its taller zooids and smaller tentacle number (see Table II).

As *Nolella blakei* matures its zooids lengthen greatly vertically until they resemble slender, soft-walled columns. They are flexible and can twist about slightly as Figures 11, 14, 15, 17 and 18 show.

Polypide

The polypide consists of the tentacular crown (8 to 12 tentacles), the digestive tract and associated musculature.

The digestive tract terminology is in a nice state of confusion. Dr. Silén (1944) attempted to bring some order out of the chaos.

The digestive tract of *Nolella blakei* consists of the mouth, pharynx, esophagus, proventriculus (or gizzard?), stomach, intestine, rectum, and anus. The pharynx and esophagus are gray in color. The esophagus is exceedingly long in tall zooids (Figs. 15, 18). Whether the next part of the gut is a proventriculus or a gizzard could not be stated with certainty in the present material. In young zooids it was the same yellow color as the stomach. In other zooids it was yellower and thicker (a band). In still older zooids it seemed to have faintly defined teeth. Harner and

PLATE II

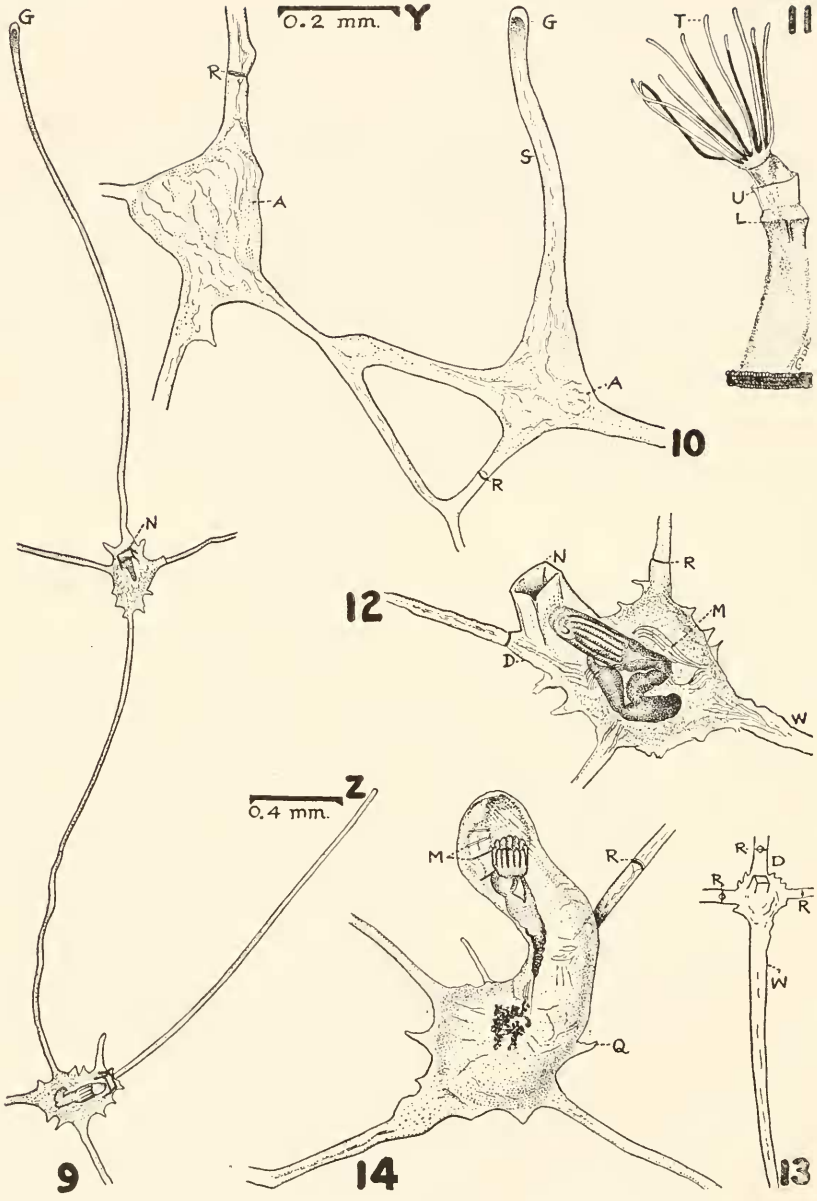
FIGURE 5. The colony of Figure 4 but drawn two days later, showing in solid black the growth and anastomoses of stolons (H, J, L, M, S, X) during that interval. The zooids (I, K, O) also have grown. Stolon N has changed its connections and the dotted part has degenerated. Drawn to Scale Y.

FIGURE 6. Diagram of polypide parts: (A) anus; (B) rectum; (C) intestine; (E) esophagus; (F) stomach or caecum; (P) gizzard? or proventriculus? and (T) tentacles.

FIGURE 7. A young zooid with 12 tentacles (T). Others in the same colony had 11. Other labels are: (D) distal part of zooid; (R) septa at the origin of the stolons; (S) stolon; (U) collar; (W) proximal extension of the zooid, one of the so-called stolons. Four stolons lead into the serrate base. Drawn to Scale Z.

FIGURE 8. A retracted zooid with 5 stolons at its base. The two distal (D) stolons anastomose. A clump of debris (V) obscures peristome area. Septa separate all stolons except the proximal one (W) from the expanded zooid base. Other labels are: (B) rectum; (C) intestine; (E) esophagus; (F) stomach; (Q) basal serrations. Drawn to Scale Z.

PLATE III



others state however that a true gizzard is lacking in this genus. The caecum or stomach is typical of various bryozoa. The intestine is narrow. The rectum is narrow and very long in tall zooids. When the polypide retracts, the gut is withdrawn into the lower part of the body cavity in a rather twisted or folded fashion (Figs. 8, 15). When the polypide begins to emerge from the vestibule the short thin membranous collar (Fig. 18U) precedes the tentacular crown. Upon emergence and expansion of tentacles the collar is some distance below the tentacles (Fig. 7U). It is so transparent that it is easily overlooked. With the extrusion of the tentacular crown the pull on the gut is such that it straightens out the coils and twists of the tract.

DISCUSSION

Nolella blakei appears to be an intermediate form between the Arachnidium, Arachnoidea, and Nolella genera. Its youngest zooids resemble the first two genera. Its mature zooids are definitely Nolella. The young *Nolella blakei* colonies resemble *Arachnoidea evelinae*, *A. protecta* and *A. ray-lankesteri* closely in the following respects. All four species have similar "stolons," squared peristome, and serrate basal enlargement, but *Nolella blakei* has fewer tentacles, and its short peristome elongates eventually into a long vertical zooid whose basal crenulations disappear with age. Other (minor) differences between *Nolella blakei* and the Arachnoidea species concern the vertical or linear extent of the peristomeal squaring and the proportionate size and diameter of peristome as compared to the basal enlargement. Also, *Nolella blakei* differs from *A. protecta* (Harmer, 1915, Plate III, Figs. 9, 10) in the much larger size of the latter's setigerous collar.

Nolella blakei resembles *Arachnidium fibrosum* (Marcus, 1938, Plate XII, Fig. 29A) in type of stolons and crenulated basal border. It differs from *A. fibrosum* in smaller tentacle number and in the absence of numerous bristle-like encrusted cuticular outgrowths originating from the peristome and basal enlargement's upper surface. Moreover, Arachnidium has a rounded peristomeal orifice rather than a squared one.

PLATE III

FIGURE 9. An especially long young branch showing a transparent growing tip (G) and two young zooids with squared peristome (N). All septa have not yet formed. Drawn to Scale Z.

FIGURE 10. Eight stolons (S) and two zooid anlagen (A). This represents Circle X of Figure 3. Drawn to Scale Y.

FIGURE 11. Upper part of a zooid with extended polypide, showing 11 tentacles (T), transparent membranous collar (U) and a slightly debris-covered peristome (L). Drawn to Scale Y.

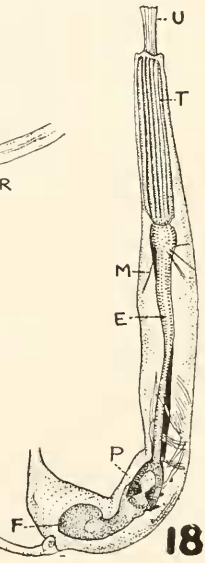
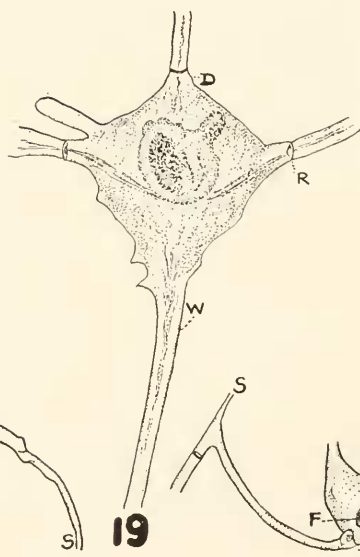
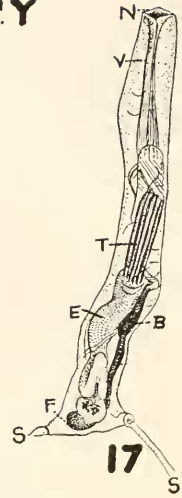
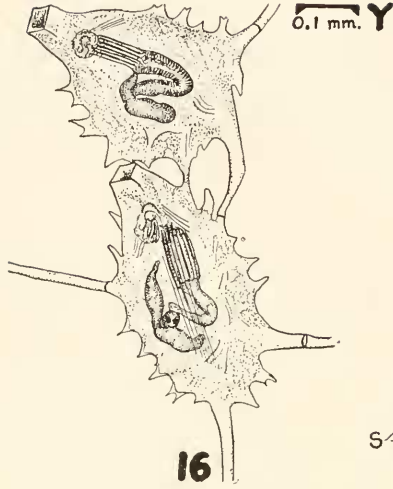
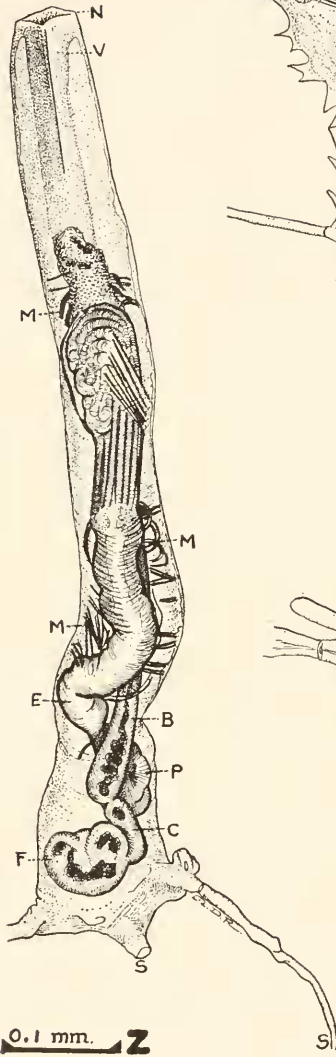
FIGURE 12. Young zooid with squared peristomeal orifice (N) and retracted polypide. Other structures: (D) distal part of zooid; (M) muscles; (R) septum and (W) proximal extension of zooid. Drawn to Scale Y.

FIGURE 13. Diagram showing relations of stolons and septa (R), with respect to the distal (D) and proximal (W) parts of a zooid, the flattened crenulated base and the rising squarish peristome in a very young colony. Considerable modification occurs in older zooids (see Figs. 15, 17, 18).

FIGURE 14. Detail of Circle Y of Fig. 3, shows a young flexible zooid beginning its upward growth. Drawn to Scale Y.

PLATE IV

15



The genus *Nolella* (formerly *Cylindroecium*) contains a number of species, most of which differ from *Nolella blakei* in tentacle number (see Table II). *Nolella alta* and *Cylindroecium pusillum* both have about 10 tentacles. However, *Nolella alta* differs from *Nolella blakei* in having wider and longer zooids. These are about double or more the width and in some instances ten times as long as those of *Nolella blakei*. *Cylindroecium pusillum* (Hincks, 1880a, pages 537 to 538) differs slightly in appearance of the expanding "stolon" as it approaches the zooid base, being somewhat more like a small *Victorella* in that respect than is *Nolella blakei*. Hincks gives very little data on it. *Nolella blakei* differs from *Nolella sawayai* (Marcus, 1938, Plate XII, Fig. 30) in bodily proportions and cuticular outgrowths. Erect *sawayai* zooids are about as long but about twice as wide as those of *blakei*. Also, encrusted cuticular processes jut out in all directions from the upright tube and peristome in *sawayai* but not in *blakei*.

O'Donoghue incompletely described and figured three *Nolella* (*Cylindroecium*) species: *C. repens* (1923, page 50); *C. spinifera* (1924, Plate IV, Fig. 27, page 59) and *C. horridum* (1926, p. 61), but gave no measurements or tentacle numbers. His *repens* had basal processes but the zooids tapered too sharply from base to tip, like a wedge or sugar beet. His *spinifera* and *horridum* had numerous spines about the lower part of the peristome, so were quite unlike *Nolella blakei*.

In summary, *Nolella blakei* resembles in one way or another a number of *Nolella*, *Arachnoidea* and *Arachnidium* species but differs from most in tentacular number and from some species in other characteristics as growth habit, body proportions, relative size, etc.

SUMMARY

Perophora viridis, collected from Martha's Vineyard, Mass., and brought into the laboratory for culturing, yielded a bryozoan, *Nolella blakei* n. sp., which was cultured and observed alive for a time. *Nolella blakei* is an intermediate form whose young zooids resemble those of *Arachnoidea* and *Arachnidium* but whose older zooids are definitely *Nolella*. It was erected a new species on the basis of its tentacle number (8 to 12) and general zoarial and zooecial characteristics. It increases to 88 the number of bryozoans known from the general Woods Hole region.

PLATE IV

FIGURE 15. An older zooid, probably not full grown, shows the changed proportions of base to upright part of zooid. The digestive tract and zooecial tube are greatly elongated. The basal crenulations are absent. Labels: (B) rectum; (C) intestine; (E) esophagus; (F) stomach; (M) muscles; (N) squared peristomeal orifice; (P) gizzard? or proventriculus?; (S) stolon; (V) vestibule. Drawn to Scale Z.

FIGURE 16. An enlarged view of the two zooids of Figure 4 (P) as they looked after seven days' growth. The stolons between them are short. Drawn to Scale Y.

FIGURE 17. An older retracted zooid with a long gut. Labelled as in Figure 15, including tentacles (T). Drawn to Scale Y.

FIGURE 18. Another older zooid showing a stolon (S), the exceptionally long and narrow esophagus (E) and rectum, the partial extrusion of the collar (U) and the tentacles (T). Drawn to Scale Y.

FIGURE 19. A very young basal enlargement showing the anlage of the future polypide in the center. It was debris-covered and hence difficult to study. Labels: (D) distal part; (R) septum; (W) proximal extension of zooid. Drawn to Scale Y.

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